FERTBRASIL: AN INNOVATIVE NETWORK FOR THE DEVELOPMENT OF TROPICAL SOILS FERTILIZERS

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Abstract

This paper aims to present the FertBrasil network, a network leaded by the Brazilian Agricultural Research Corporation – Embrapa, that includes more than three hundreds of researchers in more than fifty institutions, among public agents, universities and private companies. First, we introduce the subject of network innovation and a little background on tropical fertilizers. Then, we present the FertBrasil network, since its creation, passing by its leadership, partners and the products the network intends to develop. After, a little is discussed about the innovative control mechanism of the network and the product development flow, as well as the interaction between FertBrasil and other governmental initiatives or public policies about the same subject. At least, we discuss about the results of the network until now, in terms of products, technologies and political impacts and mobilization in fertilizers research for tropical regions. Then, we conclude presenting some challenges for FertBrasil network as well as reinforcing the important role assumed by this network in contributing to Brazil keeps its high position in agricultural production and productivity.

Keywords

FertBrasil; innovation network; tropical fertilizers;

1 INTRODUCTION

Agriculture in Brazil has been a great issue in the last years. The country has grown and it has been playing an important role in the global market. The agribusiness sector is important in terms of economy, employment and trade balance for Brazil [3].

Considering agriculture, one of the most important issues refers to soil fertility and use of fertilizers, which are responsible, at the last sense, for notable increases of tillage productivity. Soil fertility management paradigm came to an emphasis in external input but with little or no significant recognition accorded the role of organic resources in 1960s and 1970s to biological management of soil fertility as part of sustainable agriculture in the 1980s and, then, to a combination of organic resources and inorganic fertilizer, which still remains as the nowadays paradigm [24] [18].

Soil fertility and fertilizers are considered sub-areas of a greater subject named soil science. According to Raina et al., research in soil science should be driven to an innovation systems framework, because in a rapidly changing economic, ecological, political and organizational context, researchers must be prepared to work with complexities of agricultural innovation and help agricultural research policy-making [16].

One of these complexities is related to knowledge about tropical soils and the development of fertilizers that fit tropical soils agriculture. Many of producers and researchers develop products which are useful for northern countries, as European and North American ones. Of course there has been research on tropical soils and its uses [14] [22] [23] but when it is concerning to fertilizers, research and production are still broadly concentrated in the northern countries, which demand some efforts towards an innovation system approach.

Johne distinguishes three types of innovations: product innovation, process innovation, and market innovation [9]. Product innovation is related to new products development for generating revenues, process innovation is concerned to changes in processes for improving quality and saving costs, and market innovation is about development of strategies for reaching some new markets or creating new strategies to better serves the existing markets. Some cases demand product, process and market innovation and for these complexities, a possible alternative is to use the innovation network approach.

Networks between firms often seem very complex and provide an original perspective of the competitive dynamics of an industry [21]. It involves relationship-specific tasks, initiation, exchange, coordination, cross-relational tasks, planning, organizing, staffing, controlling, specialist qualifications, and social qualifications [17] and has five critical success factors: cooperation between parties, coordination of activities, communication between people, creativity, and level of chaos [1]. Innovation networks should prioritize intellectual property protection [20], exist only for business purposes [12] and create value to all its participants [2].

Concerning to agriculture, innovation networks must be demand driven and market oriented [15], as well as there should be a high level of integration between public and private sectors, in order to help policy-makers. [19] [15].

Innovation networks should mix private and public agents, as well as researchers and non-researchers [11]. Institutional experiments are enabling people to learn how to remove institutional blockages and create opportunity for innovation through institutional change [10]. So, one model of innovation network is the Triple Helix, that preconizes the existence of three supports needed to that innovation occurs: university, industry and government. In

this model, these three supports frequently interact, many times creating some new institutional arrangements [7].

So, it has been necessary to construct a network which main task would be developing technologies in fertilizers, to increase the efficiency of its applications on tropical soils. In this network, innovation will occur supported by a triple helix structure, considering that the different challenges of capital and infrastructure are different between developed and growing countries [25] [8]. This network, which will be described in Section 2, is now formed and leaded by Embrapa Soils, the unit for soils research which is part of Brazilian Agricultural Research Corporation – Embrapa.

2 FERTBRASIL NETWORK

Prices of fertilizer in Brazil had a large increase in the years of 2007 and 2008, reaching 40% of total costs of production for some grains, like corn and soybeans. This speedy increase, which was starting to unbalance the fertilizers market in Brazil as well as the whole food production supply chain demanded some integrated action of Government.

Hence, Ministry of Agriculture, Livestock and Food Supply of Brazil has started to mobilize some important players in the sector to act, which were the Agricultural and Livestock Confederation, the Ministry of Mines and Energy, Embrapa as well as other players. Then, Ministry has decreed the Fertilizer National Plan, which would consist on a set of rules to reestablish the market in the sense of its social, economic, politic and innovations aspects. One of these actions that come from the Plan is the FertBrasil network.

FertBrasil network was created in 2009. Although it had been designed and structured inside Embrapa, since its first conceptions FertBrasil has been projected to be a network that integrates a huge amount of partners that could contribute in fertilizers research.

Embrapa works by projects, and it means that every researcher can elaborate and lead a project on the company. Submitted projects must be connected with the theme of the submitter unit and often have some collaboration of people from other units or outside. Each project is evaluated by a committee at the Embrapa's central headquarters in Brazilian capital, Brasilia, according to its objectives, methods and scientific relevance. As these projects have an individual financial support from Embrapa's central headquarters (company acts as employer as well as funding agency for its own projects), there is some competition among units to approve its own projects and to use a greater part of these resources.

Thus, the company has a structure that is as the same competitive, because units compete for resources, and cooperative, because units cooperate in projects of other units. This simultaneity is called coopetition and it is an important element to strength production and innovation on a system [13].

Embrapa has six project lines they call MacroPrograms. When one submit a project, it must be allocated on a MacroProgram. In Table 1, it is shown what drives each MacroProgram.

Table 1: Macroprograms of Embrapa

Macroprogram 1	Major National Challenges
Macroprogram 2	Competitiveness and Sector Sustainability
Macroprogram 3	Agribusiness Incremental Technology Development
Macroprogram 4	Technology Transfer and Corporate Communication
Macroprogram 5	Institutional Development
Macroprogram 6	Support to the Development of Family Farming and to the Sustainability of Rural Areas

Source: Embrapa [4]

FertBrasil was submitted as a MacroProgram 1 project. The theme of tropical fertilizers is a question of national interest and should congregate a relevant amount of researchers and research institutions.

Network's main goals are the development, evaluation, validation and transfer of products and processes that contribute to increase efficiency and to introduce new sources of nutrients in Brazilian agriculture [5].

According to FertBrasil website, network mission is: "Develop, evaluate, validate and transfer technology in fertilizers adapted to tropical agroecosystems, contributing to increase efficiency and to introduce new sources of nutrients in Brazilian agriculture"; its mission is: "Being a reference in the generation of technological bases, and in the environmental and agronomic evaluation of new fertilizers.";

The main strategies that will drive network purposes are good practices for the efficient use of fertilizers, identification of alternative sources of nutrients for Brazilian agriculture and new technologies in fertilizers [5].

Its structure is perfectly aligned with the principles of Triple Helix, as it has been seen at Introduction section. Thus, one can see that FertBrasil network congregates government, universities and private partners. Embrapa is the leader of project and represents the governmental side of the helix. FertBrasil has participation of 20 Embrapa research centers (Embrapa units), counted from an amount of 47 units, which means that this project is widely recognized as an important factor to strenght agricultural sector in Brazil. These research centers provide 130 researchers in many knowledge areas to study the different aspects which involve soil fertility and the development of fertilizers for tropical soils.

In addition to these internal researchers and with the intention to compound a network which is aligned to the principles of Triple Helix, there are other 73 research and extension institutions and 22 private companies on fertilizers sector [5].

In Table 2, one can see the internal research centers, the research and extension institutions and the private companies that compound FertBrasil network. Names were kept in their original language (most of them are in portuguese) to make future searches about each one of these partners easier.

Table 2: FertBrasil partners

EMBRAPA UNITS	UNIVERSITIES	PRIVATE COMPANIES AND OTHER GOVERNMENTAL INSTITUIONS
Embrapa Solos (Soils)	Universidade Federal do Rio de Janeiro (UFRJ)	International Potash Institute (IPI)
Embrapa Cerrados	Universidade Federal de Lavras (UFLA)	Associação Nacional de Difusão de Adubos (ANDA)
Embrapa Suínos e Aves	Universidade de Brasília (UnB)	Associação Brasileira para Pesquisa da Potassa e do Fosfato (POTAFOS)
Embrapa Milho e Sorgo	Universidade de Rio Verde (FESURV)	Petrobrás Fertilizantes S.A. (PETROFÉRTIL)
Embrapa Arroz e Feijão	Universidade Estadual do Norte Fluminense Darcy Ribeiro (UENF)	Magnesita S.A.
Embrapa Soja	Universidade Federal de Viçosa (UFV)	Agrária Indústria e Comércio Ltda
Embrapa Agropecuária Oeste	Universidade Federal Rural de Pernambuco (UFRPE)	Amazon Pesquisa Mineral e Mineração Ltda.
Embrapa Agrobiologia	Universidade Federal de Goiás (UFG)	Instituto do Fosfato Biológico
Embrapa Pecuária Sudeste	Universidade Federal do Espírito Santo (UFES)	Indústrias Celta Brasil Ltda.
Embrapa Agroindústria de Alimentos	Escola Superior de Agricultura Luiz de Queiroz (ESALQ)	Produtos Minerais e Agrotecnológia Ltda.
Embrapa Amazônia Oriental	Universidade do Estado do Rio de Janeiro (UERJ)	Perdigão Agroindustrial S.A.
Embrapa Algodão	Universidade Federal de Roraima (UFRR)	Itafós Mineração Ltda
Embrapa Rondônia	Centro de Ciências Agrárias (UFSCAR)	Ecobase Engenharia e Comércio de Produtos Ambientais Ltda.
Embrapa Roraima	Universidade Federal do Tocantins (UFT)	Bunge Fertilizantes S.A.
Embrapa Caprinos e Ovinos	Fundação Universidade do Tocantins (UNITINS)	Mosaic Fertilizantes do Brasil
Embrapa Trigo	Universidade Federal de Viçosa (UFV)	Centro de Tecnologia Mineral - CETEM
Embrapa Meio Ambiente	Instituto de Geociências e Recursos Minerais da UnB (IGRM/UnB)	Empresa K+S Brasileira Fertilizantes e Produtos Industriais Ltda.
Embrapa Agroindústria Tropical	Centro Agropecuário da Universidade Federal do Espírito Santo (CAUFES)	Fertilizantes Fosfatados S.A.
Embrapa Inteligência Tecnológica	Universidade Federal Rural do Rio de Janeiro (UFRRJ)	Fertilizantes Fosfatados S.A.
Embrapa Estratégia e Negócios	Universidade Federal do Ceará (UFC)	Ministério da Ciência e Tecnologia (MCT)
Embrapa Clima Temperado	Instituto Federal de Educação, Ciência e Tecnologia de Goiás (IFGO)	Centro de Energia Nuclear na Agricultura (CENA)
Embrapa Tabuleiros Costeiros	Fundação Universidade Federal do Vale do São Francisco (UNIVASF)	Cooperativa Agroindustrial dos Produtores Rurais do Sudoeste Goiano Ltda. (COMIGO)
Embrapa Mandioca e Fruticultura	Universidade Estadual Paulista - Campus Jaboticabal (UNESP)	Empresa Mato-Grossense de Pesquisa, Assistência e Extensão Rural (EMPAER-MT)
Embrapa Semiárido		Clube de Plantio Direto do Oeste Baiano
Embrapa Soja (Goiânia)		Agência Nacional do Petróleo (ANP)
Embrapa Informática Agropecuária		Alcoa Alumínio S.A.
Embrapa Amazônia Ocidental		Instituto Agronômico de Campinas (IAC)
Embrapa Estratégia e Negócios (Ponta Grossa)		Instituto de Pesquisas Energéticas e Nucleares (IPEN)

Embrapa Hortaliças	Ministério da Agricultura, Pecuária e Abastecimento (MAPA)
Embrapa Transferência de Tecnologia	Associação de Plantio Direto no Cerrado (APDC)
Embrapa Acre	Companhia de Pesquisa de Recursos Minerais (CPRM)
	Empresa Baiana de Desenvolvimento Agrícola S.A.
	Confederação da Agricultura e Pecuária do Brasil (CNA)

Source: Embrapa Soils [6]

In order to organize workflow of all these agents working together, project has been subdivided in Component Projects (CP), and then, in Action Plans. So, all activities of the project are allocated in an action plan. In Table 3, one can see all component projects and its respective action plans. It is important to note that every component project has an action plan that is associated with the management of the component project. One can also see that one of the component project is associated with the management of the whole project, which is the network. Although it looks like some kind of redundancy, this repetition of management issues inside each layer of the project is crucial to accounting proceedings and to assure the cohesion of the project as time passes and challenges change.

Table 3: Component Projects and Action Plans

COMPONENT PROJECTS	ACTION PLANS
CP 1 - FertBrasil Management	FertBrasil finance management
	FertBrasil comunicating and promoting
	FertBrasil technical management
	FertBrasil innovation managemnt
CP 2 - Technological basis for producing new fertilizers	CP 2 management
	Technological basis for producing aggregated technologies fertilizers
	Technological basis for producing organic and organomineral fertilizers
	Technological basis for producing fertilizers from stones
	Biologial processes to increase efficiency of fertilizers
CP 3 - Efficiency of fertilizers and validation of new technologies	CP 3 management
	Increasing efficiency of conventional fertilizers
	Agronomic efficiency evaluation of agrominerals as alternative sources of nutrients
	Agronomic efficiency evaluation of organic rejects as alternative sources of nutrients
	Agronomic efficiency evaluation of aggregated technologies fertilizers
	Biological processes evaluation of fertilizers efficiency
CP 4 - Environmental impact and food quality coming due to use of new fertilizers	CP 4 management
	Nitrogen flows associated with the use of new fertilizers
	Elements, traces and other contaminants and their bioactivity in soils treated with new fertilizers
	Impact of new fertilizers in food quality
	Energy balance of new fertilizers productiomn processes
CP 5 - Innovation and transfer of new technologies in fertilizers	CP 5 management
	Intellectual property, technological information, access to genetic resources and fertilizers legislation
	Zoning and demand prospection for new technologies in fertilizers
	Transfer and commercial exploitation of new technologies in fertilizers

2.1 Strategies for product development

Among the three axes of acting of FertBrasil network, the one that presents more interest to this work is the third one, which is linked to the innovation processes and the development of new kinds of fertilizers.

Original structure of the network under a project form, as it is exposed in the past section, is not enough to a good comprehension and management considering the point of view of product development flow.

For each new fertilizer conceived, there is some effort on research, market analysis, lifecycle analysis and transfer of this technology to national industry, to make it available to rural producers. Network leaders have noted that project could have some parallel structure that associates, on a direct way, each technology to some leader. So, beyond the formal structure that coordenates the network by planned and executed jobs, there should be some other structures that control these activities by its technologies.

Thereby it has been created the technology guardians. The technology guardian is someone who is strictly linked with some specific technology. This person has knowledge enough to guide its development through the stages of conception, making and transferring to the market. They are also responsible for monitoring more efficiently the management of technologies generated in complex projects involving a large number of internal and external partners, being able to respond at any time by their state of development. The technology guardian can be either from technical team of Embrapa or from an educational/research institution which is partner on the project.

So, one can digest technology guardian's main functions as it follows: monitoring the entire process research and monitoring the development of the technology for which (s)he is responsible; managing and organizing information related to the technology under their mentoring; and playing as the facilitator between the research group related to technology and the external public.

His / her desirable profile is being expert in the area involving the stages of technology development, having a consolidated curriculum on the knowledge field, and a good articulation and recognized leadership within his research group.

Another important part of this new parallel structure is the Innovation Manager. (S)he is not worried about each technology in particular, but with the whole amount of technologies that compounds FertBrasil network. Differently from technology guardians, it is important that innovation manager comes from Embrapa technical team. It happens because (s)he will deal with Embrapa institutional roles and will work with FertBrasil in a whole, which, though it has many partners, it is a Embrapa network.

Information technology guardians have to manage about each technology are all set in a worksheet which main fields are: name, description, stage of development (research, development, transferring, or available to market), scheduled time to transfer, responsible unit, name of technology guardian, partners, contracts related to technology, intellectual property information and other information.

Innovation management works as an element that will put together all information obtained from technology guardians about each technology, setting and managing a worksheet containing this data.

This way, it becomes much easier to get some information about a given technology (consulting its technology guardian) as well as to get some information about FertBrasil product development as a whole (consulting FertBrasil innovation manager).

2.2 Results and Outcomes

There is some bureaucracy associated with both public agents innovation process and intellectual property issues in Brazil. Time to deal, develop, manage, contract and transfer are considerably higher in public companies than in private ones. It happens because public agents are subjected to laws that ensure good market practices and clear criteria for competitiveness among companies which would be interested in participate somehow in FertBrasil network.

This higher time makes that until now, there are no results in the sense of tropical fertilizers developed by FertBrasil network and already available to market.

By the way, FertBrasil network has some intermediate results that corroborate its importance and assure that Brazil will have some new tropical fertilizers available to market soon.

These intermediate results include two fertilizers delivered by the network, though they are not transferred yet. Both are granulated organomineral fertilizers, one of them coming from poultry litter and the other coming from swine rejects.

Organomineral is a class of fertilizers that join mineral elements with organic compounds. So, nitrogen (N), phosphorus (P) and potash (K), which are the macroelements responsible for plants nutrition (also known as NPK), come both from mineral sources and from organic ones. Being granulated means that these are slow release fertilizers. Granulate form, instead of powder or liquid one, makes the dispersion of nutrients slower, what is better for crop growth.

The poultry litter organomineral fertilizer has been developed by Embrapa Soils and Embrapa Swine and Poultry, inside the FertBrasil network. This technology contributes to solve not only the search for alternative sources of fertilizers in agricultural but the final destination of these poultry litters. Poultry litters contain chicken droppings, corn and sawdust. It has been used a time ago to feed the cattle, but it is not allowed anymore due to sanitary restrictions. This way, these litters were becoming a significant environmental issue for chicken producers. As the technology of producing this fertilizer is also a low-carbon technology, which reduces the greenhouse gas emissions from comparing to only organic fertilizers, these poultry litter organomineral fertilizers delivered by FertBrasil network will give a valorous help in both agronomical and environmental matters.

In the same sense, it has been developed the swine rejects organomineral fertilizers. It has been conducted by Embrapa Soils, with partnerships of Rio Verde University, in the State of Goiás and Perdigão, one of the leader companies on swine processing in Brazil. (Embrapa, 2009) It can be noted that this technology presents a whole body of Triple Helix model: government, university and private company.

Swineculture in Brazil has living a boom. Attracted by the good prices of swine feed, swine producers has been moving to grain production areas, specially the Brazilian Midwest. Lots of tons of swine rejects (feces) are produced daily and, as poultry litters, it has also been becoming an environmental issue. So, agricultural use has been becoming a need for those rejects. Then, FertBrasil network project to make them fertilizers is a good way to deal with this agroenvironmental issue.

3 CONCLUSION

FertBrasil network plays an important role on the search, development and availability of tropical fertilizers in Brazil. At the same time, network connects a research project, a public policy and ns institutional framework to solve one of the most urgent problems of contemporary Brazilian agriculture.

Through some innovations on its structure, network has found a singular solution to the problems of managing such a complex portfolio of technologies: the use of technology guardians and of an innovation a manager.

Leaded by Embrapa Soils, and within researchers, institutions and private companies from all over the country (sometimes from abroad), FertBrasil has already delivered two technologies: theorganomineral fertilizers coming from poultry litters and from swine rejects. Although it is not available to market, network is effective on purpose, join and connect all relevant stakeholders to develop tropical fertilizers in Brazil.

Future studies should follow new developments on the network, monitoring its growing, its relationships with other groups and networks, and specially, the process of technology transfer to make FertBrasil network tropical fertilizers available to market.

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